REMARKS/ARGUMENTS

In response to the Office Action mailed April 6, 2006, Applicants amend their application and request reconsideration. No claims are added or cancelled so that claims 1-5 remain pending.

An error in the Preliminary Amendment of claim 4, not previously noticed, is corrected. Claim 5 is also corrected. Through a word processing error, the same line appeared twice in that claim in the Preliminary Amendment.

The invention concerns a steering control apparatus for a vehicle. The control apparatus may be applied to a wireless electric power steering apparatus in which there is no mechanical connection between the shaft of a steering wheel and the mechanism that changes the angle of steered wheels of the vehicle. In addition, the steering control apparatus according to the invention can be applied to a steering system when there is a mechanical connection between the steered wheels and the steering wheel as, for example, described with respect to the embodiments of Figures 9, 10, and 12 of the patent application.

In the steering control apparatus according to the invention, the steering shaft reaction torque is estimated and a reference road reaction torque is estimated. These estimated torques, relating to the turning force applied to the steering wheel to resist its turning and to the turning force applied by the road and resisting the turning of the steered wheels, are used to establish a target steering reaction torque that, in turn, is used to drive a motor. This motor provides a reaction torque to the steering wheel so that the person operating the vehicle receives a tactile indication of the steering. Otherwise, based upon experience in steering strictly mechanically, the person operating the vehicle becomes quite uncertain with respect to steering.

Claim 1, the sole pending independent claim, describes the determination, i.e., generation, of the target steering reaction torque, which is a target value of a steering reaction torque to be applied to the steering wheel to provide the tactile feedback to the driver. That target value steering reaction torque is generated using the steering shaft reaction torque that has been estimated and the reference road reaction torque that has

been estimated. This feature distinguishes the claimed invention from the prior art so that claim 1 and dependent claims 2-5 are patentable.

Claim 3 was indicated to be allowable.

Claims 1, 2, 4, and 5 were rejected as anticipated by Ogawa (U.S. Patent 6,763,908, hereinafter Ogawa). This rejection is respectfully traversed. Applicants note that while there is no common inventorship in Ogawa and the present patent application, the present patent application and Ogawa are commonly assigned. Upon perfection of the priority date of the present patent application, Ogawa can only be prior art pursuant to 35 USC 102(e).

Although the Examiner provided a basis for the rejection of claim 1, the sole pending independent claim, as anticipated by Ogawa, at pages 2 and 3 of the Office Action, that reasoning is insufficient to establish anticipation of any pending claim.

Applicants agree that Ogawa describes a target reaction production means 15 that might be considered, in some ways, to correspond generally to the target steering reaction torque generation means of claim 1. However, the way in which Ogawa determines the target reaction is completely different from the claimed invention and cannot even suggest the claimed invention. For example, at column 5, lines 15-20, Ogawa describes generating the target steering reaction torque based upon steering wheel angle, not either of the quantities specified in claim 1 as used in determining the target steering reaction torque. As described in that column 5 of Ogawa, this reaction torque is calculated based upon a detected steering wheel angle supplied by a sensor 12. That sensor is used, through the first and second reaction torque control means 16 and 17 of Ogawa, to control motors 801 and 902 which apply torques to the steering wheel. This disclosure fails to describe or suggest employing an estimated steering shaft reaction torque in combination with an estimated reference road reaction torque to establish a target steering reaction torque as in claim 1.

Even the prior art described in Ogawa, for example at column 2 in lines 42-47, does not describe nor suggest a modification of the other parts of Ogawa to produce the claimed invention. In that described prior art apparatus, the target steering reaction torque is obtained from the steering wheel angle and from a vehicle state signal. Neither

of the steering shaft reaction torque nor the reference road reaction torque are part of the vehicle state signal so that not even a suggestion is found in this description for the invention as defined by the pending claims.

Figures 2 and 3 of Ogawa and the associated descriptions made reference to a self-alignment torque which might be considered related to the road reaction torque of the present patent application. However, the description in Ogawa relates only to a transmission route of the self-alignment torque in order to act upon a steering mechanism.

Further, the description in Ogawa in column 6, at lines 37 and 38, cannot suggest that the steering reaction torque is controlled using the road surface reaction torque. Again, that passage merely indicates the transmission route of the self-alignment torque in acting upon the steering mechanism of the vehicle equipped with the Ogawa power steering apparatus. The cited passage in Ogawa describes transmission of power corresponding to the road surface reaction torque, adjusted by an assist torque provided by the electric power steering apparatus, to a driver operating the steering wheel of the vehicle. To the extent that disclosure relates at all to the invention claimed, it only describes setting a target steering reaction torque based upon steering wheel angle without any consideration of road surface reaction torque.

If the Office Action takes the view that the combination of Ogawa's target reaction production means 15 and angle detection means 12 correspond to the reference road reaction torque mentioned in claim 1, the Office Action is in error. The steering wheel angle and the reference road surface reaction torque do not have a one-to-one relationship. Rather, several other factors, including the coefficient of friction of a road surface and vehicle speed, determine the relationship between steering shaft reaction torque and reference road reaction torque. The complexity of this relationship is mentioned in the present patent application in describing the problem to which the invention is directed at page 3, lines 8-10. In the invention, by using the steering shaft reaction torque and the reference road reaction torque in determining the target steering reaction torque, even when the coefficient of friction of the road surface changes, an appropriate target steering reaction torque can still be established. In terms of the hysteresis characteristic of Figure 3 of the patent application, the invention makes it

possible to control both the slope of the characteristic shown in that figure as well as the hysteresis width. This control provides the important improvement in tactile reaction sensed by a driver, providing improved steering control.

Applicants point out that the hysteresis characteristic of Figure 3 is only exemplary and is based upon assumptions that vehicle speed and coefficient of friction of a road surface are constant, providing the linear region of the characteristic illustrated. In practice, the slope of the characteristic and the hysteresis width change whenever the coefficient of friction of the road surface and/or vehicle speed change. If, for example, the slip angle of wheel becomes large, the steering shaft reaction torque becomes saturated so that the steering wheel angle and the reference road surface reaction torque may not have a linear relationship. In that instance, the steering wheel angle does not uniformly correspond to the reference road surface reaction torque so that it is impossible to use the steering wheel angle to determine that quantity. In the present invention, the steering control apparatus responds to such a change in road surface friction coefficient, and a change in vehicle speed, through the use of the steering shaft reaction torque and the reference road reaction torque in order to set the target steering reaction torque, which is not even suggested by Ogawa.

A single example serves to illustrate an advantage of the invention that cannot be provided by Ogawa. When the coefficient of friction of a road surface becomes small, i.e., the road becomes slippery, then the slope of the characteristic of Figure 3, i.e., the steering shaft reaction torque with respect to the steering wheel angle, is reduced. The lines of that graph become more nearly horizontal. In the invention, since the target steering reaction torque is established using the estimated steering shaft reaction torque and the estimated reference road reaction torque, the target steering reaction torque is reduced as its two constituent quantities are reduced. Therefore, a driver can immediately feel, through the steering wheel, that the road surface has become slippery. By contrast, in Ogawa, since the target steering reaction torque is set by the steering wheel angle and the steering reaction torque is not changed, even on a slippery road surface, the driver of the vehicle including the Ogawa power steering apparatus cannot feel, through the steering wheel, that the road surface has become slippery. In other words, the ability of

the driver to respond to changed driving conditions through tactile sensation is significantly different and inferior in Ogawa as compared to the present invention. These advantages of the invention are directly attributable to the differences between the invention as claimed and Ogawa, distinguishing the invention from Ogawa and showing the absence of even a suggestion for the invention in Ogawa.

No claim is substantively amended and no claim is amended in response to any prior art rejection. Therefore, any new rejection based on newly cited prior art or a different legal ground cannot properly be a final rejection.

Upon reconsideration, the rejection of claims 1, 2, 4, and 5 should be withdrawn and all of claims 1-5 allowed.

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Date: July 19, 2006
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